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Senior High School

CURRICULUM GUIDE

Vocational Series

MACHINE SHOP 12 - 22 - 32

(Interim Edition, September 1967)

Province of Alberta

Department of Education

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COURSE CREDIT VALUES

Machine Shop 12 . . . . . 5 credits

Machine Shop 22 . . . . . 15 credits

Machine Shop 32 . . . . . 15 or 20 credits

One credit corresponds to a minimum of 40 minutes of instruction time per week.

FOREWORD

Man has been working metal for thousands of years. He has progressed from the time that he replaced his stone axes and spears with bronze weapons up through the Iron Age and into the Age of Machines. The Machine Age began about 300 years ago when man began to learn how to use sources of power other than his own brute strength and that of his animals. He invented new machines, used the power of the wind, the water and coal to operate them and save his back in the process.

Most everything that is produced today, whether it be for food, clothing or shelter, is processed by machines. Today's machines have developed far beyond the simple application of steam power and the use of levers to control the machines. The machines of today are electronically operated by pushbuttons. In order to operate the machines of today, skilled technicians, not just machine operators are indispensable. Such men must be capable of interpreting and carrying out ideas that call for the production of new and extremely intricate parts. In addition to skill, they must possess knowledge, judgment, confidence, orderliness and safe work habits before they can be considered to be skilled craftsmen. More and more of the repetitive skills are being done by machine. The machinist today must work more and more with his head. Knowing the "why" has become just as important as knowing "how" to do the job.

GENERAL OBJECTIVES

1. To impart to the student, a knowledge of the role the machinist plays in industry and the opportunities that exist in this field.

2. To equip a student with sufficient skill and knowledge such that he will be highly employable in the machinist trade.

3. To enable a student, entering the machinist apprentice program, to advance at an accelerated rate on the basis of his proven ability on the job.

4. To prepare a student to a degree of competency acceptable to the Institutes of Technology, sufficient for entry into Year B of the Industrial Production Technology and Manufacturing Technology programs.

SPECIFIC OBJECTIVES

1. To enable students to operate power machines efficiently, accurately and safely.

2. To acquaint students with the basic types, features and functions of machinery used in the machinist trade.

3. To develop desirable habits concerning safety, good working relationships, and proper use of time and material.

4. To develop high standards of workmanship.

5. To familiarize students with the principles and practices involved in accurate measuring and working to close tolerances.

6. To develop the skills and knowledge required to interpret blueprints accurately as well as to produce accurate drawings.

7. To familiarize students with the different types of metal used in industry.

1. Course Credit Value:

Machine Shop 12 - 5 credits
Machine Shop 22 - 15 credits
Machine Shop 32 - 15 or 20 credits

NOTE: 5 credits of drafting are included in each of Machine Shop 22 and 32.

2. Time Allocation

It is recommended that in the Machine Shop 12, 22 and 32 courses, one-third of the time be given to theory and two-thirds to shop practice.

3. Safety Program

Every shop must have an effective safety program. In the machine shop, particular attention must be given to the safety measures required in the industry: adequate guards; cleanliness of shop and personnel maintained at a high standard; students properly clothed for their work; etc. Shop organization must be such as to ensure stressing this very important phase of the shop program.

A good safety program features the following devices: regular, consistent and thorough instruction, constant vigilance and checking by the instructor; safety posters; student safety committee; adequate first aid equipment, instructor trained and up-to-date in first aid methods; symbolic color painting of machines and equipment; adequate working space about machines; safety lines on floor around machines; routine report on accidents however minor; machines and tools in approved working condition; a safety-conscious group of students and instructor.

4. Instructor's Records

The instructor should keep accurate records of:

a. Student enrollment and attendance.
b. Student personnel.
c. Student work carried.
d. Theory covered.
e. Tests given.
f. Student achievement.
g. Up-to-date inventory of all equipment.

5. Student Records

Instructors should ensure that the student develops and maintains a neat and accurate record of:

a. Notes on theory.
b. Daily shop activities (time cards).

6. Enrolment

The recommended enrolment for machine shop classes is 16 students and under no conditions should it be allowed to increase beyond 20. Two classes may easily be combined for the presentation of theory.

7. Guidance and Vocational Information

Instructors must assume responsibility in their trade area to ensure that students and school guidance officials are aware of the local situation. It is essential that the instructors be active, interested and informed regarding the opportunities in the trade.

NOTE: In order to permit students from an academic Grade X program to cross over into the vocational program at the Grade XI level, schools may combine the 12 and 22 courses into one course for a total of 20 credits. Where these courses are combined it is recommended that students purchase the Grade XI text only.

Whereas the Machine Shop 12 course is an exploratory course open to all Grade X students, the Machine Shop 22 and 32 courses are definitely vocational and only those students who have displayed ability and aptitude for the program should be encouraged to continue. It is not fair to the student to permit him to continue in a program which demands a large portion of his school time, and in which the instructor and/or the guidance counsellor feel that he has little chance of success.

8. Projects

It is expected that some projects will be used in Grade X and to a limited degree in Grade XI and XII as vehicles of instruction and as a means of securing and retaining student interest. The onus is on the instructor to ensure that the projects selected involve only those operations specified in the course outline, and that the time required to complete the project does not encroach upon the time needed to learn other skills and operations.

INSTRUCTIONS ON THE USE OF THIS MACHINE OUTLINE

The course outline is divided into three columns entitled: Operations, Basic Information and References. The first column outlines the type of activity performed on the machines in the shop. The second column refers to the essential information upon which a skilled operator in the machine industry will depend to adequately carry out the operations outlined in the first column. It includes knowledge of a general nature regarding the trade and the industry, that is not directly related to the operations. The third column lists numbers which correspond to reference books from the prescribed texts. The references are listed in the back of the curriculum guide. The reference column is not considered to be complete. Instructors are requested to insert reference which they consider most suitable for the particular topics outlined. It would be reasonable if instructors would also note the time spent on the various units. This information will be advisedly referred to the curriculum committee in revising this outline.

The authorized text for machine shop 1 is MACHINE SHOP THEORY AND PRACTICE by E.H. Hallett now published by the Macmillan Company of Canada Limited.

The authorized text for Machine Shop 2 and 3 is MACHINE TOOL METAL CUTTING by Palmer and Tatro now published by the McGraw-Hill Company of Canada.

OBJECTIVES FOR MACHINE SHOP 12

The machine shop course in Grade X is considered to be exploratory in nature. The knowledge and experience gained should enable the student to make an informed decision in regard to his possible future in this field.

More specifically, the objectives for Machine Shop 12 are as follows:

1. To impart occupational information related to the opportunities in the machine industry.

2. To develop basic skills in the care and safe use of hand and power tools and equipment.

3. To learn and provide opportunity for the students to practice the correct and safe procedures involved in operating the lathe, power saw, drill press, and grinder.

4. To learn the different types of metal and their uses in regard to machine work.

MACHINE SHOP 12 COURSE OUTLINE

Operations	Basic Information	References
UNIT I: The Machinist Trade - (3 hours)		
Familiarization tour of the shop; outline shop procedure and routine.	General shop safety rules. Types of work, working conditions, opportunities for employment and advancement; the apprenticeship Program; Institutes of Technology Programs.	1, 2, & 3
UNIT II: Layout Work - (4 hours)		
Lay out work using the tools and instruments listed to the right.	Layout tools and instruments, their description and use; scriber, dividers, combination set, steel rule, layout fluid, center punch, ball peen hammer, prick punch, steel square, hermaphrodite caliper, surface plate.	
UNIT III: Bench Work - (30 hours)		
Sometimes it is impossible, inconvenient, or inefficient to shape stock on power machinery. Consequently, it is important for machinist to develop the skills required for bench metal work. The purpose of this unit is to acquaint pupils with the tools commonly used in bench work and their correct uses.		
Hammering.	Types, features, and applications of hammers, e.g., machinist's, riveting, soft, mallets.	
Chiselling.	(a) Safe practices, e.g., the use of goggles and the removal of mushroom heads. (b) Types, features and applications of chisels, e.g., cold, cape, side, diamond. (c) Correct chiselling procedures.	
Punching.	Features and uses of various punches, e.g., solid, center, prick, drift, blanking.	

Operations	Basic Information	References
Sawing.	(a) Types, features, and applications of hacksaw blades.	
	(b) Correct method of use of hacksaw on various materials and kinds of material.	
Filing.	(a) Nomenclature and selection of files.	
	(b) Principles and techniques of filing, including draw filing.	
Drilling on the drill press.	(a) Sizes and specifications of drills.	
	(b) Methods of holding stock while drilling.	
	(c) Methods of drilling holes using hand and portable power drills and drill press.	
	(d) Countersinking methods.	
Hand tapping and external threading.	(a) Hand tools - wrenches, screwdrivers.	
	(b) Types, features and applications of standard screw threads.	
	(c) Screw thread calculations, e.g., pitch, diameter, tap drill, size, etc.	
	(d) Methods of holding and driving hand taps.	
	(e) Precautions concerning tap breakage.	
	(f) Methods of holding and driving dies.	
	(g) Cutting oils.	

Operations	Basic Information	References
Fitting.	(a) Common metal fasteners and their uses, e.g., bolts, nuts, screws, rivets, keys, taper pins, etc.	
Polishing Metal.	(a) Types and functions of abrasive materials such as stones, powders and cloths.	
	(b) Correct procedures.	
General Work.	(a) Methods of holding work, e.g., vises, clamps, jigs, stops, fences.	
	(b) Safety principles and practices.	

UNIT IV: Metallurgy - (8 hours)

Competence in machine shop work requires some ability and understanding in metallurgy. Instruction should cover the following topics:

(a) Common metals.

(b) Production of iron and steel.

(c) Identification of metals.

(d) Properties and uses of metals.

(e) Heat treatment, principles, procedures and applications.

UNIT V: Lathe Work - (70 hours)

Truing up work, facing or squaring, parallel turning, parting, chuck turning, turning between centers, drilling, tapping, using the micrometer caliper.	(a) Parts of the machine, their features and their functions.	
	(b) Methods of mounting work.	
	(c) Types, features, functions and limitations of chucks.	
	(d) Methods of truing up work.	

Operations	Basic Information	References
	(e) Features and functions of measuring and testing tools, e.g., calipers, micrometer, gauges, indicators.	
	(f) Selection and control of speeds and feeds.	
	(g) Types and lathe tools, their design and their function.	
	(h) Methods of mounting cutting tools.	
	(i) Safety principles and practices.	
Center drilling, drilling.	(a) Types, features and functions of drills.	
Filing.	(a) Types of files and their uses.	
Polishing.	(a) Kinds of abrasive materials and their uses.	
	(b) Types of lathe tools, their design and functions.	
Taper turning.	(a) Types, features and functions of tapers.	
Cutting V threads.	(a) Taper settings in degrees.	
UNIT VI: Power Sawing - (3 hours)		
Sawing different kinds, shapes and thicknesses of materials.	(a) Types, features and functions of power saws.	
	(b) Principles and practices in operating power saws.	
	(c) Methods used in holding various sizes and shapes of materials, e.g., long and short bars, angle iron, tubing.	
	(d) Coolant.	
	(e) Safety principles and practices.	

Operations	Basic Information	References
UNIT VII: Drill Press Work - (10 hours)		
Drilling, drilling for tapping purposes, countersinking, boring, reaming.	(a) Parts of the machine and their functions.	
	(b) Uses of vises, stops and clamps.	
	(c) Uses of chucks, sockets, and sleeves in holding drills.	
	(d) Types, features, sizes, and functions of drills.	
Demonstration of drill grinding.	(a) Principles and practices in grinding drills.	
	(b) Selection of speeds and feeds.	
	(c) Production methods.	
	(d) Methods of measuring, testing, and gauging.	
	(e) Coolants and cutting oils and their uses.	
	(f) Safety principles and practices.	
UNIT VIII: Grinding - (3 hours)		
Grinding hand tools such as chisels, screwdrivers, scribers, and center punches.	(a) Types, features and functions of abrasives and grinding wheels.	
	(b) Tool designs for various machines and operations.	
	(c) Taking care of the grinding wheel surface.	
	(d) Safety principles and practices.	
Dressing a grinding wheel (Demonstration only).	(a) Types of wheel dressers and the techniques involved in using them.	

Special Note

This course has a total credit value of 15 and is broken down as follows:

Part I: Mechanical Drafting - 5 credits
Part II: Machine Shop Practice and Theory - 10 credits

In those schools where the machine shop students have already completed Drafting 10 or 12 in Grade X, the time for drafting may be reduced considerably and limited to a review of Drafting 12 theory and practice to improve drafting skills.

Under no circumstances should the drafting portion be deleted as a result of the student having taken Drafting 10 or 12. Where the drafting time is reduced in keeping with the above instructions, the additional time gained should be spent in machine shop practice.

It is further recommended that the drafting portion of the course be spread over the entire year and that the content be related as closely as possible to the work in the machine shop. Although a high degree of drafting skill may be desirable, it must be remembered that the primary objective of the drafting portions of this curriculum is to develop the ability to read and understand drawings and prints made by draftsmen so that the "machinist" can carry out the instructions given in the drawings, in the shop.

PART I: MECHANICAL DRAFTING FOR MACHINE SHOP 22

(5 credits)

Instructions on the Use of the Drafting Portion of the Course Outline

The pages are divided into three columns marked: Basic Information, Operations and Projects, and References. The first column might be considered as information that must be covered by the instructor in class. The second column is a guide to the student's activities. This covers explicit operations and skills that the student must master. The third column refers to places in various reference books that the instructor should become familiar with in order to successfully present the required information.

The code for this reference section is as follows: The letter prefix indicates the reference book. The number series following it indicates the page number followed by a comma. The next series indicates the paragraph number. In some cases, a figure number may be given. This is denoted by a figure as a prefix, i.e., G p.123,173 would mean Giesecke, page 123, paragraph 173.

The Reference Books are coded as follows:

A — Almon, Basic Mechanical Drawing, Bruce.

C.S.A. — Canadian Standards Association, Mechanical Engineering Drawing Standards, B78.1.

C.G.S.B. — Canadian Government Specifications Board, Architectural Drawing Practices, 33-GP-7.

F — French and Vierck, Engineering Drawing, 9th edition. McGraw-Hill Book Company, New York. (Canadian representative - McGraw-Hill Book Company of Canada Limited, Toronto, Ontario)

F S — French and Svenson, Mechanical Drawing, and problem sheets, Levens and Edstrom, Pts. 1 and 2.

G — Giesecke, Mitchell and Spencer, Technical Drawing, 4th edition. Macmillan Company, New York. Canadian representative - Brett-Macmillan Company, Galt, Ontario.

M — McLaughlin, Montieth, Tarry & Terney, A Course of Study in Drafting for Canadian High Schools, Tyrell Press, 80 Lebreton Street, Ottawa 1, Ontario.

Z — Zozzora, Engineering Drawing, McGraw-Hill Book Company, New York. Canadian representative - McGraw-Hill Book Company of Canada Limited, Toronto, Ontario.

In the event of conflict between texts, the C.S.A. and C.G.S.B. manuals will be the final authority.

The projects that are listed are to be used merely as a guide to present some standard of accomplishment throughout the province. Individual instructors may select other projects of similar nature, but that would demand an equal effort from the students than those suggested in the guide.

Basic Information	Operations and Projects	References
UNIT I: Introduction		
General class organization issuing of supplies and equipment, introduction of drafting as the language of the industrial and technical world, overview of course and standards expected.	Student should begin notebook with place for Glossary of terms.	
UNIT II: Instruments and Materials		
Introduction to the tools; compasses, dividers, spring bows, T-square, set squares (30°, -60°, -45°), scales, erasers, erasing shields, sanding block, drafting tape, drawing papers, etc. Care and storage of equipment.		FP18, 2.2-2.4, 2.9-2.11, 2.14, 2.15, 2.18-- Z.P. 56 4-1 P. 57 4-5 to 4-9 P.64 4-19 to 4-24
UNIT III: Use of Instruments		
Board requirements. Fastening paper to board. Construction and use of T-square, test for accuracy. Methods of sharpening pencils. Correct methods of drawing lines, etc. Use of protractor, compass, dividers, scale (1/16 inch divisions), erasing shield, etc. Alphabet of lines, sizes of drawings. (A.S.A.)	Stress correct use of instruments. Mounting paper, border, title, block, etc. Horizontal lines, vertical lines, angles of 15 multiples using both triangles. Drawing parallel lines with set squares. Dividing a line or space by parallel line method. Drawing of different types of lines, circles, arcs, tangents. Construction lines, center lines, hidden lines, outlines, order of drawing and darkening. Suggested Projects: F - P47 Fig. 2.5.1, 2.5.2 G - P.60 Fig. 94 P.61 Fig. 96 or some of Fig. 97 P.62 Fig. 99	F P29 2.25 to 2.34, P41 2.39, 2.42, 2.43 M.P. 2,3,13,14, 15,39 Z.P. 56 4.1, 4.6 to 4-14 P. 65 4.21 to 4.24 P.67 4.26, 4.27

Basic Information	Operations and Projects	References
	M - P.84-85 Fig. D101 to 104. P.89 Fig. D118-123 (do not dimension).	
	G - P.90 Fig. 5-11, 5-15.	
UNIT IV: Lettering		
Importance of lettering in drafting. Forms of alphabets and their use. Caps and lower case. Compressed, normal and extended lettering. General proportions, order of strokes and composition. Lettering must be taught and checked all during the year.	Single stroke upper case Gothic lettering. Students should become proficient with 1/8", 1/4" and 3/8" lettering, centering of titles and title blocks, etc. Lettering on the face of drawings shall be 1/8" vertical, single stroke Gothic. Suggested Projects 2 plates $8\frac{1}{2}$ x 11 to include alphabets, numerals, fractions, words, phrases, etc. in three sizes 1/8", 1/4" and 3/8". Vertical single stroke Gothic.	F P.79, 4.1 to 4.9 G P.64, 75 to 84 P.70, 86 to 94 P.8, 2.5 to 2.15 M P.4 Z Chap. 1 except lettering devices.
UNIT V: Geometrical Construction		
Terms: points, lines, angles, triangles, quadrilaterals, polygons, circles, arcs, tangents, etc. The draftsman's method of drawing these should be demonstrated and stressed.	Bisection of a line, arc, angle. Construction of a line through a point parallel to a given line. The construction of a line parallel to a given line at a given distance from it. The division of a line into equal parts. The construction of a line through a point perpendicular to a given line. The construction of a triangle with given sides.	F P.56, 3.19, 3.27 G P.90, 107-120 Z P.71, 5.1, 5.2 F P.51, 3.22 Z P.71, 5.4, 5.5 F P.52, 3.4 Z P.71,5.3 F P.58, 3.29 Z P.72, 5.7

Basic Information	Operations and Projects	References
Applications of geometric construction.	The construction of a square.	Z P.72, 5.6
	The construction of a hexagon across corners and across flats.	F P.59, 3.33 Z P.72, 5.9
	The construction of a circle through three points not in a straight line. The construction of a circle tangent to a line at a given point. The construction of tangent arcs:	F P.60, 3.38 Z P.75, 5.14 F P.53, 3.7
	a) to two lines at right angles.	F P.54, 3.11 Z P.76, 5.19
	b) to two lines at acute or obtuse angles.	F P.54, 3.12 Z P.77, 5.20 F P.54, 3.15
	c) to an arc and a straight line.	Z P.78, 5.22

UNIT VI: The Theory of Projection Drawing

This should be considered as an introductory unit, stressing the following:

1. Drawings are necessary in the industrial world to record, express and convey ideas and information, necessary for the construction and erection of machines and structures.

2. There are different methods of drawing the representation of an object.

3. It is difficult to draw things accurately and at the same time make them appear as real objects.

4. Standard ways of representing objects are necessary for universal understanding of the representation.

Basic Information	Operations and Projects	References
The instruction should show examples of: a) single point perspective. b) two point perspective. c) three point perspective. d) isometric. e) cabinet. f) cavalier. g) orthographic. This section is to lead up to the next unit; orthographic projection.		
UNIT VII: Orthographic Projection		
1. Introduction - orthographic true shape.	Laying out and drawing of simple two and three view drawings. The instructor should select suitable objects or projects out of McLaughlin pages 86, 87 and 88 and more difficult work from pages 91, 95, 96 and 100. The instructor may also use self devised blocks and job sheets for better visualization by the students. Drawings of objects may be selected from Giesecke, pages 190 to 200. The instructor should always keep in mind student interest when selecting the drawings to be drawn by the student covering all the forementioned points under Basic Information. Sketching should be included as project work.	M P.9 G P.161-62
2. Views of an object, glass box; arrangement of views. The U.S.A. layout of views one, two and three view drawings. (Familiar with alternate view drawings, position of views, partial views.) How to balance 2 view drawing and 3 view drawing.		M P.10 M P.11 M P.14-15 G P.164, 211 Fig. 292
3. Hidden lines, the meaning of lines, the precedence of lines.		G P.224-276 G P.224, 225, 226
4. Transferring depth measurements.		G P.227, 228, 229
5. Visualization - interpretation of views.		

Basic Information	Operations and Projects	References
6. Surfaces, edges, corners, normal surfaces and edges, inclined surfaces, oblique surfaces.		
7. Scale drawings.		
8. Orthographic sketching. (See Unit XI).		
UNIT VIII: Dimensioning		
Introduction:		McL P.17-23
a) Size description.		G P.298, 328
b) Scale of drawings.		G P.299, 329
c) Lines used in dimensioning.		G P.310, 331
d) Placement of dimension and extention lines.	1. Dimensioning problems from the text.	G P.301, 332
e) Arrowheads and leaders.	2. Problem sheets - could be made up and have the pupils place the proper dimensions.	G P.302-3, 533-4
f) Fractional and decimal dimensioning.	The previous units can be dimensioned, after all the factors in dimensioning have been covered.	G P.303-4, 335
g) The lettering and reading of dimensional figures.		G P.304-5, 336
h) Symbols for feet and inches.		G P.305-6, 338
i) Dimensioning, angles, arcs, fillets and rounds.		G P.306-7, 339
j) Size dimensioning of holes.		P.340, 341
		G P.313, 349
UNIT IX: Isometric Drawing		
	Student should draw a number of simple isometric drawings, as outlined in pages 114-5 of McLaughlin and/or pages 510-513 of Giesecke. The	G P.482, Fig. 823
		G P.483, 450 Fig. 825

Basic Information	Operations and Projects	References
1. Isometric drawing.		
a. The position of isometric axes.	instructor when selecting drawings, should always keep in mind the points under Basic Information and student interest.	G P.452-3, Fig. 826 M P.47
b. Offset location measurements.		G P.485,453, Fig. 829 G P.485-6
c. Hidden lines in isometric drawings.	Sketching should be included as project work.	G P.454, Fig. 832-3 G P.486, 456
d. Center lines.		G P.486, 457, Fig. 835
e. Box construction.		M P.48 G P.489, 458 Fig. 836
f. Non-isometric lines.		G P.487, 469 Fig. 857a
g. Isometric dimensioning.		G P.487, 469 Fig. 857a and 858
h. The use of isometric drawings in industries.		
UNIT X: Oblique Projection		
1. Types of oblique projection.	Drafting jobs on oblique projection may be chosen from McLaughlin, pages 136-7 or, and Giesecke, pages 526-28.	McL P.50 G P.516, 482
a. Cabinet projection.		McL P.50
b. Cavalier.		McL P.50-51
2. The choice of position of the object.		G P.519, 485 Fig. 884-5
3. The steps followed.		G P.519, 486 Fig. 886
4. Dimensioning an oblique drawing.		McL P.51
5. Sketching in oblique.		G P.524, 491 Fig. 895

NOTE: Student should make drawings of the same object by each of the oblique above methods of projection.

Basic Information	Operations and Projects	References
UNIT XI: Technical Sketching		
Value of technical sketching.		M P.10
A means of expression of ideas that are difficult to put in words. A simple and quick means of expressing an idea. (Thinking with a pencil.)		G P.129-130
Sketching materials.		G P.130
Pencil H, HB.		M P.10-11
Eraser.		Z P.42
Paper: Plain, white, squared, isometric, thin paper, placed over dark lined, squared or isometric paper.		
Line technique.		
Outline. Dimension line. Invisible line.	Draw several drawings requiring various types of lines. It would be desirable to use several of the types of paper listed in column one.	G P.130-131-132 Z P.44-45
Circles, arcs and ellipses.		
Blocking in circles. Use of radial lines. Use of squared paper to draw circles. Isometric paper and ellipses.	One exercise in freehand drawing of curved lines, circles and ellipses. Make use of models available in the classroom. Also choose one figure that contains some of the above from Zozzora, pages 52-55. Students should make sketches of many of the drawings they will complete at a later date.	Z P.47

Basic Information	Operations and Projects	References
UNIT XII: Primary Auxiliary Views		
Primary auxiliary view.		
This is a view projected to a plane perpendicular to one of the three principal planes; front, top or side and inclined to the other two.		Z P.167 Z P.168, Fig. 9.1
How to draw an auxiliary view.		
How to draw a reference line parallel to the edge of a view. The reference line can be considered a folding line. The reference line is used to locate points on the auxiliary view. The convenience and accuracy gained when the reference line is passed through a plane or points of the object itself.	Draw an object similar to the one shown. Use classroom models as samples for auxiliary views. See also McLaughlin, P.43-44.	Z P.121, Fig. 9.7 G P.235, Fig. 472
Construction of auxiliary views. (simple objects)		
Procedure for simple auxiliary views.	One drawing of a very simple object.	Z P.173, Fig. 9.9
Partial auxiliary views.		
The practice of showing only the shape and details of the inclined surface and not a view of the entire surface.		Z P.173 G P.242
Auxiliary view to complete a principal view.		
A situation is often encountered where an auxiliary view is necessary to complete other views. Know the procedure of showing the incline plane as an edge to construct a principal view.	One drawing of a simple object where partial auxiliary views may also be used on the same drawing.	Z P.173 Z P.173, Fig. 9.10

Basic Information	Operations and Projects	References
True length of line.		
True length of line seen only on a plane of projection.		Z P.174 Z P.175, Fig. 9.13
UNIT XIII: Sections		
Full Sections.		
A longitudinal line extending through an entire object.		Z P.141 M P.28 G P.207
Cutting plane.		
A portion of an object nearest the observer that has been removed by means of a cutting plane to reveal section lines and arrows.	Draw a simple section from a model or from examples in Z, pages 33, 34, 35, 36.	M P.28 G P.210 Z P.141, 8.2
Offset sections.		
Placing the cutting line through other than the main axis so that it shows direct features and details.		M P.32 Z P.142, 8.3 G P.217-255
Section lining.		
A method of distinguishing sections by lining. The drawing of parallel lines across all surfaces cut.	Draw a simple full section. Examples may be a section of a pipe, bearing or flange. Student should do several simple drawings to develop some skill. One drawing should be of such a nature that special angle lines need to be used.	Z 142 G P. 208-209 M P.29
Section lining technique.		
Proper line angle for good contrast. Use of symbolic section lining.	A simple drawing that must be lined at a special angle. Include a drawing lined to indicate material. This could be a drawing of standards used, etc.	G P.209 Z P.143, 8.8 M P.29

Basic Information	Operations and Projects	References
Visualizing a section.		
Make use of drawing in text. Use mockups made of wood.		M P.33-34 G P.211, 249
Breaks and ribs in sections.		
When cutting plane cuts flatwise through a web gear tooth or flat element, a false impression of solidity should be avoided. The flat rib should not be sectioned.	Any one of the above drawings could contain a rib or web.	G P.218-223 Z P.151, 8.22
Kinds of section.		
Half.	If time permits.	
A symmetrical object drawn so that only half of it is sectioned. One side of the center line only.	One simple drawing that could contain several of these sections.	M P.30 Z P.146, 8.12 G P.21A
Broken out.		
A section drawn not indicating the cutting plane used only to show some isolated detail.	Show one isolated section of one of the above drawings.	M P.32 Z P.146, 8.13 G P.21A
Removed.		
Sections drawn similar to revolved except they are placed outside or at one side of the drawing.		M P.31 Z P.149, 8.17 G P.217 F P.28-29
Revolved.		
The imaginary cutting plane is passed through the object perpendicular to the horizontal axis and revolved on its center 90 into the paper.	One of the above drawings might be repeated to show the revolved section more clearly.	M P.31 Z P.148, 8.14

Basic Information	Operations and Projects	References
UNIT XIV: Reproduction of Drawings		
Tracing Media.		
The selection of tracing papers. Test the ability of the paper to take ink, pencil, erasing, re-inking, smooth or rough line, etc. Tendancy of paper to discolor and become brittle. Tracing cloth and its use because of durability and permanency. Good for ink and pencil. Shiny and dull side. Plastic.	Students should be able to observe the transparencies of the various papers. A demonstration with various papers would be excellent, pointing out the value of rag content.	Z P.383
	Demonstration.	Z P.384
Tracing Instruments.		
Methods of filling pen. Adjustment, proper use of pen.	Demonstration on filling and adjustment of pen for proper line. Demonstration in how to hold the pen and also use of special pens and pencils. Have students follow the demonstrations and synchronize adjustments to their instruments with that of the instructor.	Z P.385 Z P.386 Z P.389
Inks, see local reproducing company.		
Reproductions		
Blueprint Process.		
Demonstrations or lecture on methods of reproduction depending on the equipment available to the school or in the school. Blueprint papers are sensitized by applying a coat of potassium, ferricyanide and ferric ammonium citrate. Care of this paper.		G P.764 G P.765

Basic Information	Operations and Projects	References
Diazo Prints.		
A process based on light-sensitive diazo compounds, advantages of this printing process.	Students should do at least one print using this process if equipment is available.	
Reproduction Quality.		
Demonstration and lecture of what to look for in good prints. Recognize poor prints due to poor tracings, paper quality, over and under exposure.		
Photostat Prints.		
A negative made of any drawing or tracing to any desired reduction or enlargement through the use of a special camera.	Observe a sample if available. Discuss advantages.	F P.371
Thermofax, verifax, xerography microfilming and the electrolatic process. Lithography.	Know the basic general theory of each process. To be able to recognize the difference between these by observation.	
UNIT XV: Blueprint Reading		
The term applies to the reading of the language from the drawings of others. The students should be able to interpret the ideas expressed on technical drawings.	Project - Have the student read or interpret a drawing from the files or text. This could be in the form of a written assignment. Ask for some oral interpretation for confirmation of students' understanding. Have students study fellow students' drawings or special file drawings to observe errors that have been made.	

Operations	Basic Information	References
UNIT I: Layout Work - (4 hours)		
Laying out exercises or projects using the tools and instruments listed on the right.	(Advanced) Layout tools and instruments, their description and use: steel rule, layout fluid, scriber, dividers, combination set, center, punch, prick punch, ball peen, hammer, steel square, hermaphrodite, caliper, surface plate, C-clamp, trammel, vernier height gauge.	
UNIT II: Bench Work - (30 hours)		
Hammering.	(a) Types, features and applications of hammers, e.g., machinist's riveting, soft, mallets.	
Chiselling.	(a) Safety practices concerning, e.g., the use of goggles and the removal of mushroom heads.	
	(b) Types, features and applications of chisels, e.g., cold, cape, side, diamond.	
	(c) Correct chiselling procedures.	
Punching.	(a) Features and uses of various punches, e.g., solid, center, prick, drift, aligning.	
Sawing.	(a) Types, features and applications of hacksaw blades.	
	(b) Correct usage of the hacksaw on various thickness and kinds of material.	

Operations	Basic Information	References
Filing.	(a) Nomenclature and selection of files.	
	(b) Principles and techniques of filing, including draw filing.	
Drilling.	(a) Sizes and specifications of drills.	
	(b) Methods of drilling holes using hand and portable power drills.	
	(c) Countersinking methods.	
Reaming.	(a) Types, features and uses of hand reamers, e.g., solid, adjustable, expansion.	
	(b) Allowances for reaming.	
Tapping and External Threading.	(a) Types, features and applications of standard screw threads.	
	(b) Screw thread calculations, e.g., pitch, diameter, tap drill size, etc.	
	(c) Methods of holding and driving hand taps.	
	(d) Precautions concerning tap breakage.	
	(e) Methods of holding and driving dies.	
Fitting.	(a) Common metal fasteners and their uses, e.g., bolts, nuts, screws, rivets, keys, taper pins, etc.	
	(b) Techniques of fitting keys, cotters, shafts, gears, bearings, etc.	

Operations	Basic Information	References
Honing, lapping and polishing.	(a) Types and functions of abrasive materials such as stones, powders, cloths, and buffing wheels.	
	(b) Correct procedures.	
General Work.	(a) Methods of holding work, e.g., vises, clamps, jigs, stops and fences.	
	(b) Safety principles and practices.	
UNIT III: Hot Metal Work - (9 hours)		
Forging.	(a) Furnaces, tongs, anvils, hammers, forging procedure.	Machine Shop 12 Text 2
	(b) Introduction to oxy-acetylene torch (optional and demonstration only).	
Heat treating of tools and projects.	(a) Hardening of carbon and alloy steels, tempering, annealing, normalizing, case hardening.	2
UNIT IV: Lathe Work - (100 hours)		
Work in general.	(a) Safety principles and practices.	
	(b) Habits needed in taking care of the machine.	
	(c) Uses of cutting oils and coolants.	
Faceplate Work.	(a) Types, features and functions of faceplates and faceplate fixtures.	
	(b) Layout procedures.	
	(c) Principles and practices in counterbalancing.	

Operations	Basic Information	References
Work requiring the use of the steady rest and follower rest.	(a) Types, features and functions of steady rests and follower rests.	
	(b) Procedures in the use of steady rests.	
Knurling.	(a) Types, features and functions of knurling tools.	
	(b) Knurling procedures.	
	(c) Selection of speeds and feeds.	
Taper turning and boring.	(a) Types, features and functions of tapers.	
	(b) Taper calculations.	
	(c) Methods of testing and measuring tapers.	
	(d) Tools, devices and methods for boring inside tapers.	
	(e) Types, features and uses of surface high spot indicators, e.g., mechanic's blue, red lead, alcohol.	
	(f) Uses of freehand boring and scraping tools.	
	(g) Relationship of bore size to boring bar.	
	(h) Uses of the arbor press.	
Screwcutting right and left hand external and internal threads.	(a) Thread nomenclature and terminology.	
	(b) Specifications of U.N.C., U.N.F., and N.P. threads.	
	(c) Types and features of single point threading tools and chasers.	

Operations	Basic Information	References
	(d) Methods of measuring and gauging screw threads and threading tools.	
	(e) Gear calculations.	
	(f) Ratios.	
	(g) Types and uses of thread indicators.	
	(h) Methods of selecting and setting the lead for threading.	
	(i) Methods of cutting threads without a chasing dial.	
Turning and forming contours.	(a) Methods used in turning and forming contours, freehand and form tool.	
	(b) Types and applications of forming tools.	
	(c) Methods of testing and measuring contours.	
Work in general.	(a) Safety practices and principles.	
	(b) Habits required in taking care of the lathe.	
Turning on mandrels and collet chucks.	(a) Types of mandrels.	
	(b) Mounting the work and turning procedure.	
UNIT V: Milling - (50 hours)		
Work in general.	(a) Safety principles and practices.	
	(b) Habits needed in taking care of the machine.	
	(c) Uses of cutting oils and coolants.	

Operations	Basic Information	References
Milling horizontal and vertical flat surfaces; milling keyways and slots, end milling.	(a) Features and functions of different types of milling machines.	
	(b) Types, features and uses of cutters, attachments and accessories.	
	(c) Features and functions of control mechanisms.	
	(d) Selection of speeds and feeds.	
	(e) Methods of mounting cutters, attachments and accessories.	
	(f) Methods of holding the work, e.g., vises, auxiliary tables, centers, angle plates, rotary tables.	
	(g) Methods of milling to a shoulder.	
	(h) Testing and gauging methods.	
UNIT VI: Grinding - (30 hours)		
Work in general.	(a) Safety principles and practices.	
	(b) Habits needed in taking care of the machine.	
Grinding a plane surface.	(a) Types, features and functions of grinding machines.	
	(b) Methods of holding the work, e.g., vises, chucks.	
	(c) Selection of suitable wheels.	
	(d) Selection of speeds and feeds.	
	(e) Methods of keeping the work square.	
	(f) Types, features and functions of precision measuring instruments.	

Operations	Basic Information	References
Tool grinding.	(a) Types, features and characteristics of various tool materials.	
	(b) Recognition of and tests for various tool materials.	
	(c) Types, features and characteristics of tools for various jobs and materials.	
	(d) Tool design, profile and angles for roughing and finishing.	
Drill grinding.	(a) Drill terminology and nomenclature.	
	(b) Types and features of drill grinding fixtures.	
	(c) Instruments and methods for testing drills.	
UNIT VII: Shaping - (40 hours)		
Work in general.	(a) Safety principles and practices.	
	(b) Habits needed in taking care of the machines.	
	(c) Parts of the machine and their functions.	
Shaping horizontal, vertical and angular flat surfaces.	(a) Tool designs and functions.	
	(b) Methods of mounting tools for internal work.	
	(c) Precautions concerning feeds in confined areas.	
	(d) Methods of mounting work.	
	(e) Methods of cutting to a shoulder.	
	(f) Calculations for angles to be shaped.	

Operations	Basic Information	References
	(g) Methods of making starting holes for internal shaping, e.g., drilling, burning.	
	(h) Types and features of measuring and testing tools.	
Shaping external keyways.	(a) Layout techniques.	
	(b) Selection of tools.	
	(c) Types and standards for keyways.	
Serrating a flat surface.	(a) Purposes of serrating surfaces.	
	(b) Types and features of serrating tools.	
	(c) Speeds and feeds for serrating.	

MACHINE SHOP 32 COURSE OUTLINE

Special Note:

This course has a total credit value of 15 or 20 and is broken down as follows:

Part I: Mechanical Drafting - 5 credits
Part II: Machine Shop Practice and Theory - 10 or 15 credits.

PART I: MECHANICAL DRAFTING FOR MACHINE SHOP 32

The drafting portion of the Machine Shop 32 course should be spread over the entire year, and the content should be related as closely as possible to the work in the machine shop so that the students may be fully aware of the application and the need for an understanding of drafting.

Operations	Basic Information	References
UNIT I: Review - (20 hours)		
A. Lettering.		
B. Instruments and Materials.		
C. Geometrical Construction.		
D. Theory of Projection.		
E. Dimensioning.		
F. Technical Sketching (Freehand Drafting).		
UNIT II: Tolerancing - (23 hours)		
	A. Tolerancing.	
	1. Purposes of tolerancing.	G P.334
	2. Definition of tolerance.	
Students must have a clear understanding of these terms and their purpose.	3. Definitions of terms.	G P.336
	4. Fits between mating parts.	
	5. Selective assembly.	G P.337

Operations	Basic Information	References
	6. Basic hole system.	
Instructorcould prepare information sheets on this material for distribution.	7. Basic shaft system.	G P.338
	8. Unilateral tolerances.	G P.339
	9. Bilateral tolerances.	
	B. Specification of Tolerances.	G P.339
	1. Expressing tolerances.	
Students should have practice in locating and interpreting tolerances on drawings. Students should be given drawings which require the placement of tolerance specifications.	2. American Standard limits and fits.	G P.341
	3. Running and Sliding fits.	
	4. Locational fits.	G P.342
	5. Force fits.	
	6. Accumulation of tolerances.	G P.344
	7. Tolerances and shop processes.	
	8. Positional tolerances.	G P.345, 346, 347
	9. Maximum material condition.	
	10. Geometric tolerances.	G P.348
	11. Tolerances of angles.	G P.353
UNIT II: Threads, Fasteners and Springs - (20 hours)		
	A. Screw Threads.	
	1. Definitions of terms.	G P.355
	2. Screw thread forms.	G P.356
	3. Thread pitch.	G P.357
	4. Right and left hand threads.	
	5. Single and multiple threads.	G P.357

Operations	Basic Information	References
Exercises in sketching threads in detail.	6. Detailed representation of threads.	G P.359
	(a) Detailed representation of "V" threads.	G P.359
	(b) Detailed representation of square threads.	G P.361
	(c) Acme threads.	G P.363
	(d) Buttress threads.	G P.364
	7. Thread symbols.	
	(a) External thread.	G P.364
	(b) Internal thread.	G P.365
	(c) Schematic thread symbols.	
Practice drawing schematic threads and threads in section.	8. Threads in section.	G P.366
	9. American National Thread.	
	10. American National Thread fits.	
	11. S.A.E. Extra Fine Threads.	G P.368
	12. Unified and American Threads.	
Draw detail representation of Unified Threads.	13. Unified and American Thread fits.	
	14. Thread notes.	G P.369
Practice in placing of thread notes.	15. American Standard Pipe Threads.	G P.370
	B. Bolts, Studs and Screws.	
	1. Bolt.	G P.372
	2. Cap screw.	
	3. Stud.	
	4. Machine screw.	

Operations	Basic Information	References
	5. Set screw.	
	6. Tapped holes.	G P.373
	7. American Standard Bolts & Nuts.	G P.374
Draw one plate of American Standard bolts.	8. How to draw American Standard Bolts.	G P.375
	9. Specifications for bolts and nuts.	
	10. Locknuts and locking devices.	G P.378
	11. American Standard Cap Screws.	G P.380
	12. American Standard machine screws.	
	13. American Standard set screws.	G P.381
	14. American Standard wood screws.	G P.383
	C. Miscellaneous Fasteners.	
	1. Keys.	G P.384
	2. Machine pins.	P.385
	3. Rivets.	P.386
	D. Springs.	
	1. Definition.	G P.387
	2. Types.	
Draw springs in section and schematic.	3. Method of Drawing.	
	(a) Detailed.	
	(b) Schematic.	

Operations	Basic Information	References
UNIT IV: Intersections and Developments - (10 hours)		
Introduction of the basic principles only.		
UNIT V: Working Drawings - (60 hours)		
	A. Working Drawings.	
	1. Description.	F & S, P. 172
Notes on theory.	2. Purpose.	
	B. Detail Drawings.	
	1. Definition.	
	2. Purpose.	
	C. Assembly Drawings.	F & S, P. 173
	1. Description.	
	2. Purpose.	
	3. Choice of views.	F & S, P.174
	4. Choice of scale.	P.175
	5. Grouping and placing parts.	P.176
	6. Sectional views.	
	7. Rule of contour.	
	8. Rough and finished castings.	F & S, P.179
	9. Fillets and rounds.	P.180
	10. Pulleys and flywheels.	
	11. Shafting.	F & S, P.181, 182, 183

Operations	Basic Information	References
Students complete problems V.1, V.2, V.4, V.6, V.12, V.17, V.25 - F & S, P. 436.	12. Bearings. 13. Pipe. (a) Pipe threads and fittings. (b) Sizes of fitting. (c) Piping drawings.	

Operations	Basic Information	References
UNIT I: Lathe Work - (100 hours)		
Advanced turning jobs and projects.	1. Methods of mounting work for eccentric turning.	
	2. Layout procedures.	
	3. Methods of offsetting and of measuring offset.	
	4. Uses of throw blocks.	
	5. Methods of mounting complex castings.	
	6. Principles and practices in counterbalancing.	
	7. Selection of speeds and feeds.	
Turning blanks for gears.	1. Specifications for different types of gears.	
Cutting multiple-start threads; cutting acme, square and buttress threads.	1. Terminology and specifications of various types of threads.	
	2. Gear train calculations.	
	3. Types, designs, and selection of single point threading tools.	
	4. Methods of indexing work.	
	5. Methods of cutting odd pitch threads.	
	6. Methods of measuring, testing and gauging threads.	
Winding a spring.	1. Types, features and functions of coil springs.	
	2. Calculations for the making of springs.	
	3. Methods of holding the wire for winding.	

Operations	Basic Information	References
UNIT II: Milling - (90 hours)		
Milling angular flat surfaces.	1. Methods of mounting work.	
	2. Calculations of angles.	
	3. Methods of measuring flat angles.	
Milling external curved surfaces; milling external irregular surfaces.	1. Methods of roughing down and finishing curved surfaces.	
	2. Methods of laying out irregular shapes.	
	3. Methods of milling to a layout.	
	4. Methods of checking irregular surfaces.	
	5. Use and care of templates.	
Milling helical or spiral grooves.	1. Types and features of helical and spiral grooves.	
	2. Calculation of lead in helix or spiral.	
	3. Methods of checking and testing work.	
Milling spur gears.	1. Design, features and functions of spur gears.	
	2. Calculations for indexing gear blanks.	
	3. Methods of indexing work.	
	4. Methods of finishing gears.	
UNIT III: Grinding - (20 hours)		
Grinding forming tools.	1. Types, features and characteristics of tools and materials.	
	2. Tool design and angles.	

Operations	Basic Information	References
	3. Methods of forming grinding wheel faces.	
	4. Precautions concerning hand stoning.	
	5. Methods of testing profiles.	
	1. Cutoff grinding wheels.	
	2. Types and features of cutoff grinding wheels.	
	3. Types of work requiring abrasive cutoff.	
	4. Grinding machines: external and internal grinders, surface grinders, centerless grinders.	
UNIT IV: Shaping - (30 hours)		
Cutting stopped keyways.	1. Layout techniques.	
	2. Ram setting procedures for blind grooves.	
	3. Methods of measuring depth.	
	4. Tool design.	
Shaping external curved surfaces, shaping contours, shaping angular surfaces.	1. Methods of grinding and checking forming tools for curved surfaces.	
	2. Methods of measuring and inspecting curved surfaces, e.g. templates.	
UNIT V: Gauges and Gauging - (5 hours)		
	1. Types of gauges: plug, ring, pin, snap, thread plug and thread ring gauges, indicating type gauges.	
	2. Fits and tolerances.	

Operations	Basic Information	References
UNIT VI: Materials - (5 hours)		
	1. Hot and cold finished metals, alloy and tool steels, copper and aluminum alloys, bearing metals, cast irons, mechanical properties of metals.	5
UNIT VII: General Information - (15 hours)		
1. Industrial visits.	1. Employment opportunities.	
2. Speakers from industry and provincial boards.	2. Seeking employment.	
	3. Provincial apprenticeship program.	
	4. Workmen's compensation.	
	5. Unemployment insurance.	
	6. Cost estimating.	

MACHINE SHOP 12, 22, 32

REFERENCE BOOKS

Code:

1. METALWORK, TECHNOLOGY AND PRACTICE, Oswald A. Ludwig, McKnight & McKnight Publishing Co.

2. MACHINE TOOL OPERATION, Part I, Burghardt, Axelrod, Anderson, 5th Edition, McGraw-Hill Book Co.

3. MACHINE TOOL OPERATION, Part II, Burghardt, Axelrod, Anderson, 4th Edition, McGraw-Hill Book Co.

4. Apprenticeship Board Publications.

5. MACHINERY'S HANDBOOK, Oberg and Jones, General Publishing Co.

6. MACHINE TECHNOLOGY - RELATED INFORMATION - 1, 2, 3, 4, Delmar Publishers (Canada) Ltd. Instructor's Guides for Machine Technology 1, 2, 3, 4.

DRAFTING REFERENCE BOOKS

F Engineering Drawing, French and Vierck, 9th Edition, McGraw-Hill Book Company of Canada Ltd., Toronto, Ontario.

F & S MECHANICAL DRAWING, French and Svenson, and Problem Sheets, Levens and Ecstrom, Parts 1 and 2.

G TECHNICAL DRAWING, Giesecke, Mitchell and Spencer, 4th Edition, Macmillan Company, New York. Canadian Representative, Brett, Macmillan Company, Galt, Ontario.

Z ENGINEERING DRAWING, Zozzora, McGraw-Hill Book Company of Canada Limited, Toronto, Ontario.

CSA MECHANICAL ENGINEERING DRAWING STANDARDS, Canadian Standards Association, B78.1.

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